

**WHAT IS CLAIMED IS:**

1           1.       A system for performing the pseudo-spectral time-domain (PSTD) method on data,  
2   comprising:  
3               a forward fast Fourier transform (FFT) unit calculating a forward fast Fourier  
4   transform (FFT) from the data;  
5               a complex multiplication unit receiving the FFT-processed data and calculating a  
6   spatial derivative in the frequency domain from the FFT-processed data;  
7               an inverse fast Fourier transform (IFFT) unit converting the spatial derivative in the  
8   frequency domain from the complex multiplication unit into the time domain; and  
9               a computation engine solving a PSTD equation based upon the spatial derivative in  
10   the time domain received from the IFFT unit.

1           2.       A system as recited in claim 1, wherein the PSTD equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

3   where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material  
4   properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

1           3.       A system as recited in claim 1, wherein as the FFT is being calculated, primary fields,  
2   incident fields, and coefficients are being fetched by the system.

1           4.       A system as recited in claim 1, wherein the FFT and IFFT units are provided inside a  
2   field-programmable gate array (FPGA).

5. A system as recited in claim 4, wherein the FFT and IFFT calculations are performed by a digital signal processing (DSP) chip.

6. A system for performing the pseudo-spectral time-domain (PSTD) method on data, comprising:

a plurality of forward fast Fourier transform (FFT) units, each FFT unit calculating a forward fast Fourier transform (FFT) from the data;

a plurality of complex multiplication units, each complex multiplication unit receiving the FFT-processed data from a corresponding FFT unit and calculating a spatial derivative in the frequency domain from the FFT-processed data;

a plurality of inverse fast Fourier transform (IFFT) units, each IFFT unit converting the spatial derivative in the frequency domain from a corresponding complex multiplication unit into the time domain; and

a plurality of computation engines, each computation engine solving a PSTD equation based upon the spatial derivative in the time domain received from a corresponding IFFT unit.

7. A system as recited in claim 6, wherein the PSTD equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial h} + CE_{ab}^{inc},$$

where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

8. A system as recited in claim 6, wherein as the FFT is being calculated, primary fields, incident fields, and coefficients are being fetched by the system.

1           9.       A system as recited in claim 6, wherein the plurality of FFT and IFFT units are  
2       provided inside a field-programmable gate array (FPGA).

1           10.     A system as recited in claim 9, wherein the FFT and IFFT calculations are performed  
2       by a digital signal processing (DSP) chip.

1           11.     A computer hardware configuration for performing the pseudo-spectral time-domain  
2       (PSTD) method on data, comprising:

3                   a forward fast Fourier transform (FFT) unit calculating a forward fast Fourier  
4       transform (FFT) from the data;

5                   a complex multiplication unit receiving the FFT-processed data and calculating a  
6       spatial derivative in the frequency domain from the FFT-processed data;

7                   an inverse fast Fourier transform (IFFT) unit converting the spatial derivative in the  
8       frequency domain from the complex multiplication unit into the time domain; and

9                   a computation engine solving a PSTD equation based upon the spatial derivative in  
10      the time domain received from the IFFT unit.

1           12.     A computer hardware configuration as recited in claim 11, wherein the PSTD  
2       equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

4       where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material  
5       properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

1           13.     A computer hardware configuration as recited in claim 11, wherein as the FFT is  
2     being calculated, primary fields, incident fields, and coefficients are being fetched by the system.

1           14.     A computer hardware configuration as recited in claim 11, wherein the FFT and IFFT  
2     units are provided inside a field-programmable gate array (FPGA).

1           15.     A computer hardware configuration as recited in claim 14, wherein the FFT and IFFT  
2     calculations are performed by a digital signal processing (DSP) chip.

1           16.     A computer hardware configuration for performing the pseudo-spectral time-domain  
2     (PSTD) method on data, comprising:

3                     a plurality of forward fast Fourier transform (FFT) units, each FFT unit calculating a  
4     forward fast Fourier transform (FFT) from the data;

5                     a plurality of complex multiplication units, each complex multiplication unit  
6     receiving the FFT-processed data from a corresponding FFT unit and calculating a spatial derivative  
7     in the frequency domain from the FFT-processed data;

8                     a plurality of inverse fast Fourier transform (IFFT) units, each IFFT unit converting  
9     the spatial derivative in the frequency domain from a corresponding complex multiplication unit into  
10    the time domain; and

11                    a plurality of computation engines, each computation engine solving a PSTD equation  
12    based upon the spatial derivative in the time domain received from a corresponding IFFT unit.

17. A computer hardware configuration as recited in claim 16, wherein the PSTD equation takes the form:

$$E_{ab} = AE_{ab} + B \frac{\partial H_c}{\partial b} + CE_{ab}^{inc},$$

where  $a$ ,  $b$ , and  $c$  are directions (x, y, and z),  $A$ ,  $B$ , and  $C$  are coefficients based on material properties of a medium, and  $E_{ab}^{inc}$  is the incident field associated with the node.

18. A computer hardware configuration as recited in claim 16, wherein as the FFT is being calculated, primary fields, incident fields, and coefficients are being fetched by the system.

19. A computer hardware configuration as recited in claim 16, wherein the plurality of FFT and IFFT units are provided inside a field-programmable gate array (FPGA).

20. A computer hardware configuration as recited in claim 19, wherein the FFT and IFFT calculations are performed by a digital signal processing (DSP) chip.